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[54] **AUTOGENOUS FLAME SPRAYING APPARATUS FOR THE FLAME SPRAYING OF POWDER-FORM MATERIALS OR SPRAY POWDER**

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PCT Pub. Date: **Dec. 13, 1990**

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[51] **Int. Cl.**[5] **B05B 7/04**; B05B 7/20

[52] **U.S. Cl.** **239/79**; 239/85; 239/132.5

[58] **Field of Search** 239/79, 85, 132.5

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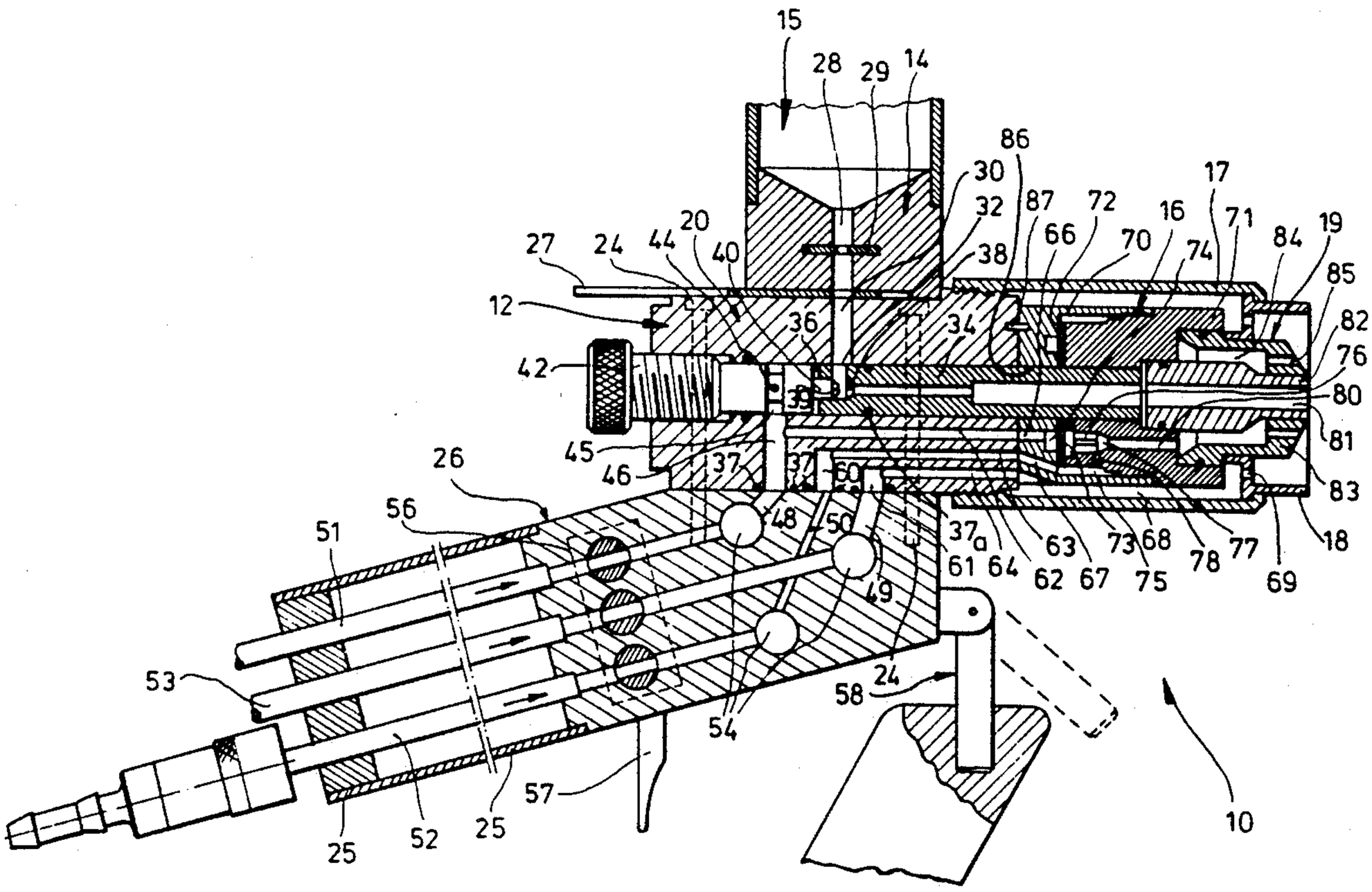
[57] **ABSTRACT**

An autogenous flame spraying apparatus includes a supply line housing having gas supply lines for combustion gas, carrier gas and acceleration gas; a main housing connected to the supply line housing and having a supply line for a spray powder, and ducts communicating with the gas supply lines, the housing having a first injector for mixing the spray powder and the carrier gas to form a first mixture; an interchangeable nozzle carrier for carrying a releasable torch nozzle, the carrier being releasably attached to the main housing and having a second injector for mixing the combustion gas and the carrier gas to form a second mixture, the nozzle carrier also having ducts for conveying the first mixture and the second mixture to the torch nozzle, whereby the carrier can be replaced so as to alter both flame power and feed of spray powder.

30 Claims, 6 Drawing Sheets



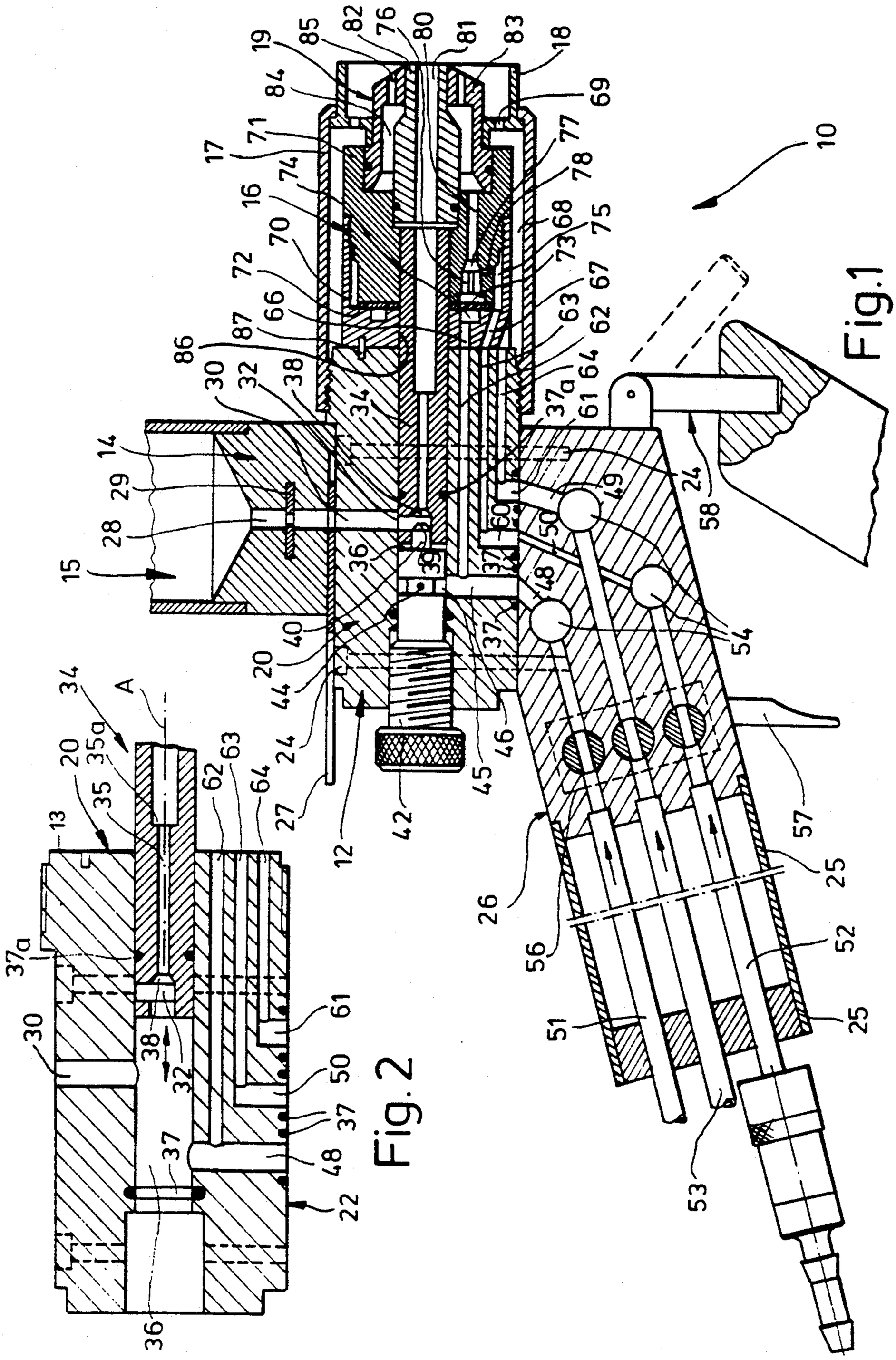

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Fig.1

Fig.2

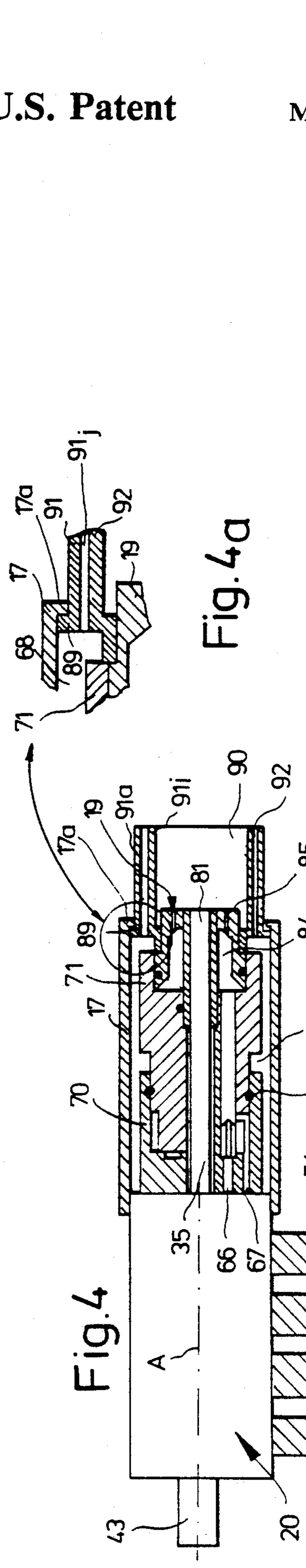

Fig.4a

Fig.3

Fig.4

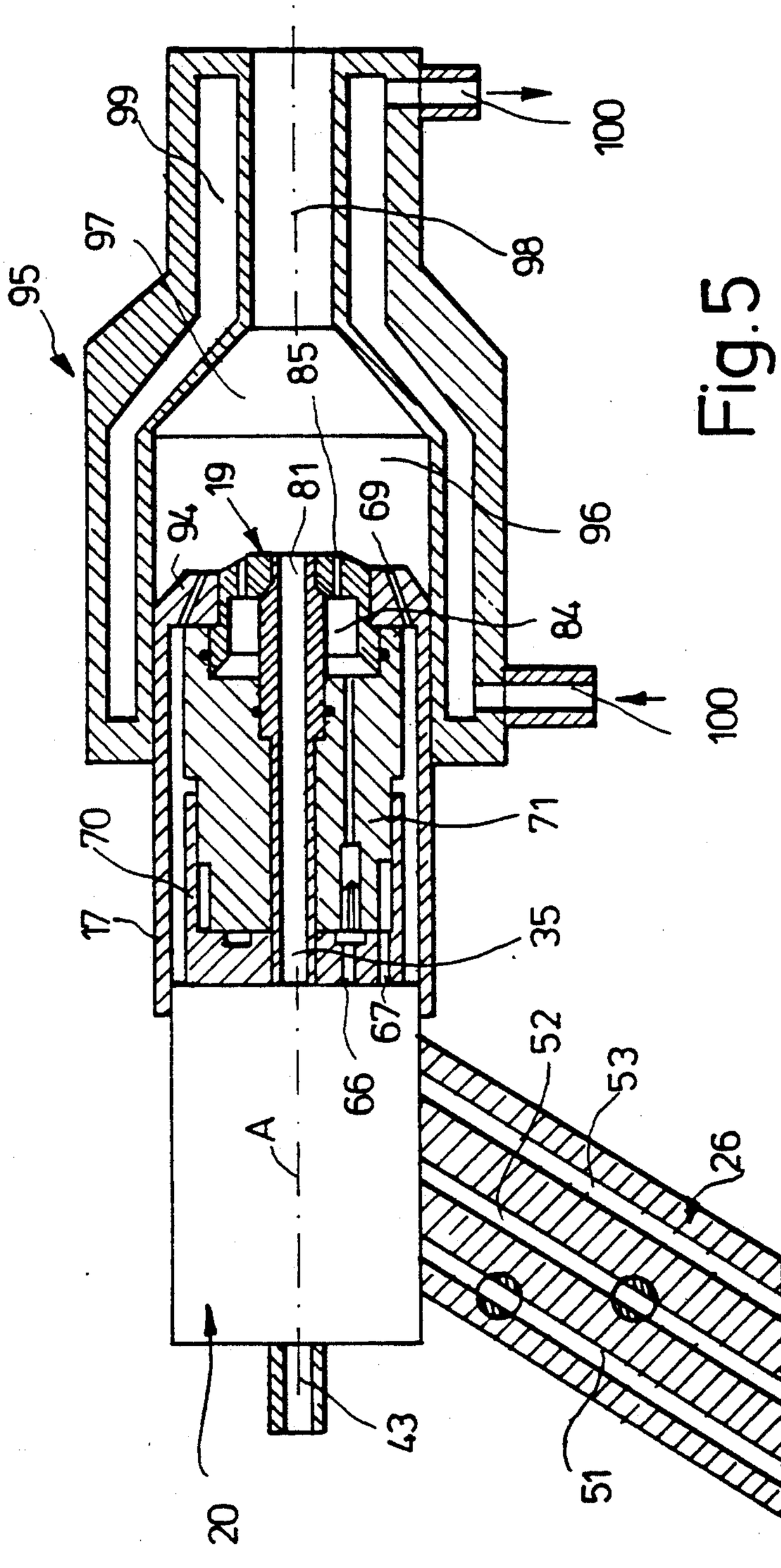
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Fig.5

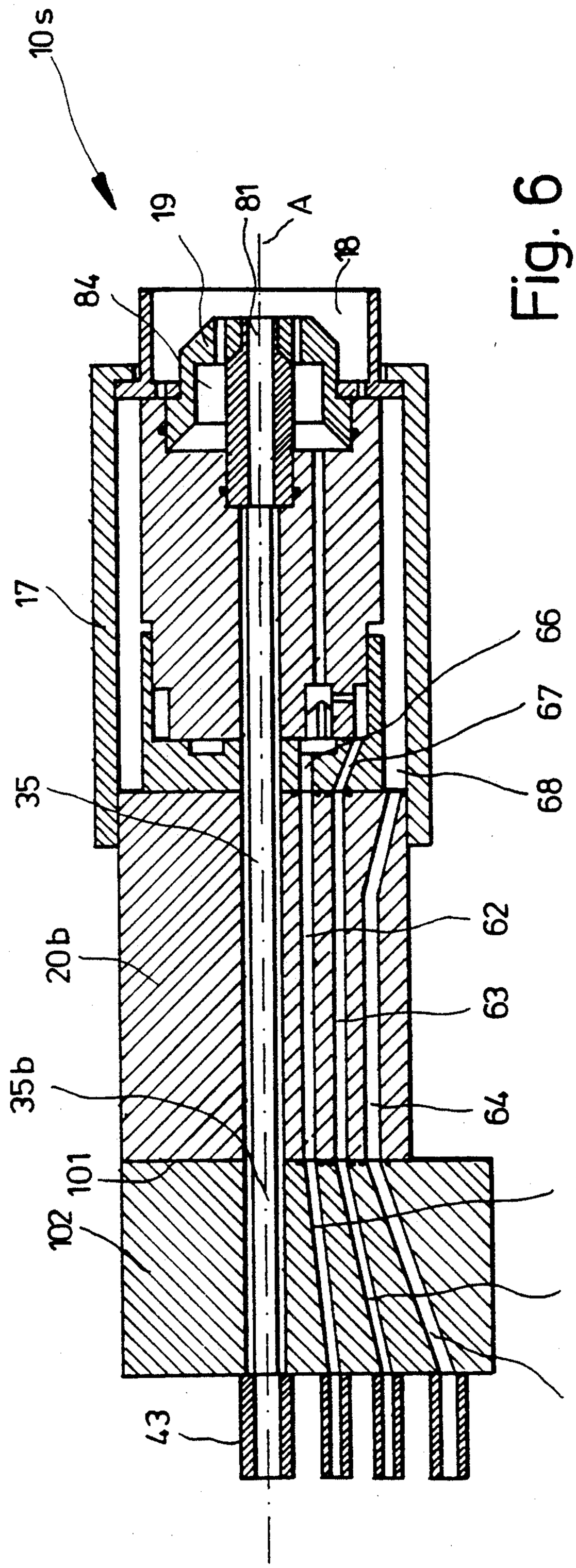

Fig. 6

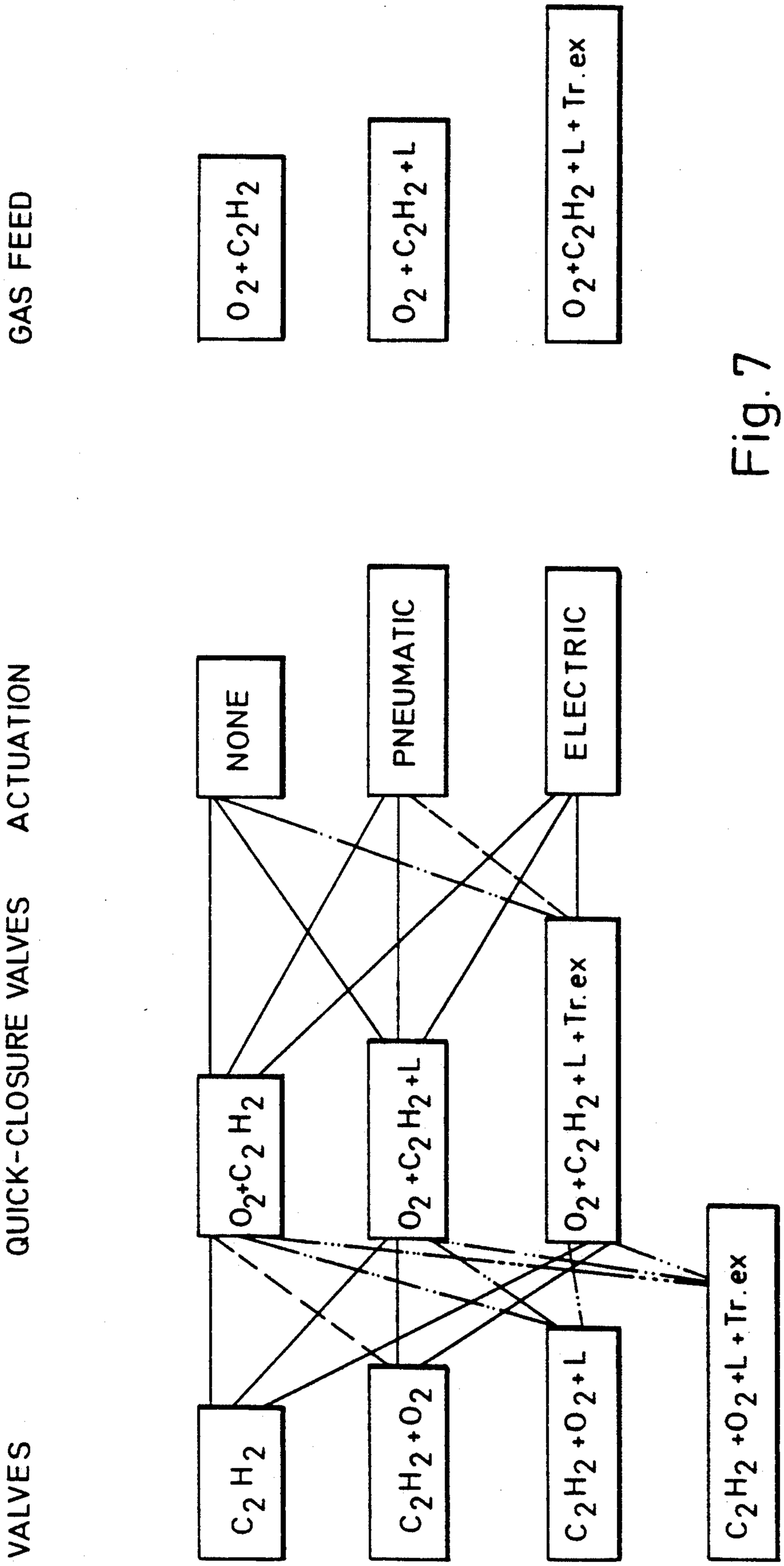
GAS FEED
ACTUATION
QUICK-CLOSURE VALVES
VALVES
O2+C2H2
O2+C2H2+L
O2+C2H2+L+Tr.ex
NONE
PNEUMATIC
ELECTRIC
C2H2
C2H2+O2
C2H2+O2+L
C2H2+O2+L+Tr.ex

Fig. 7

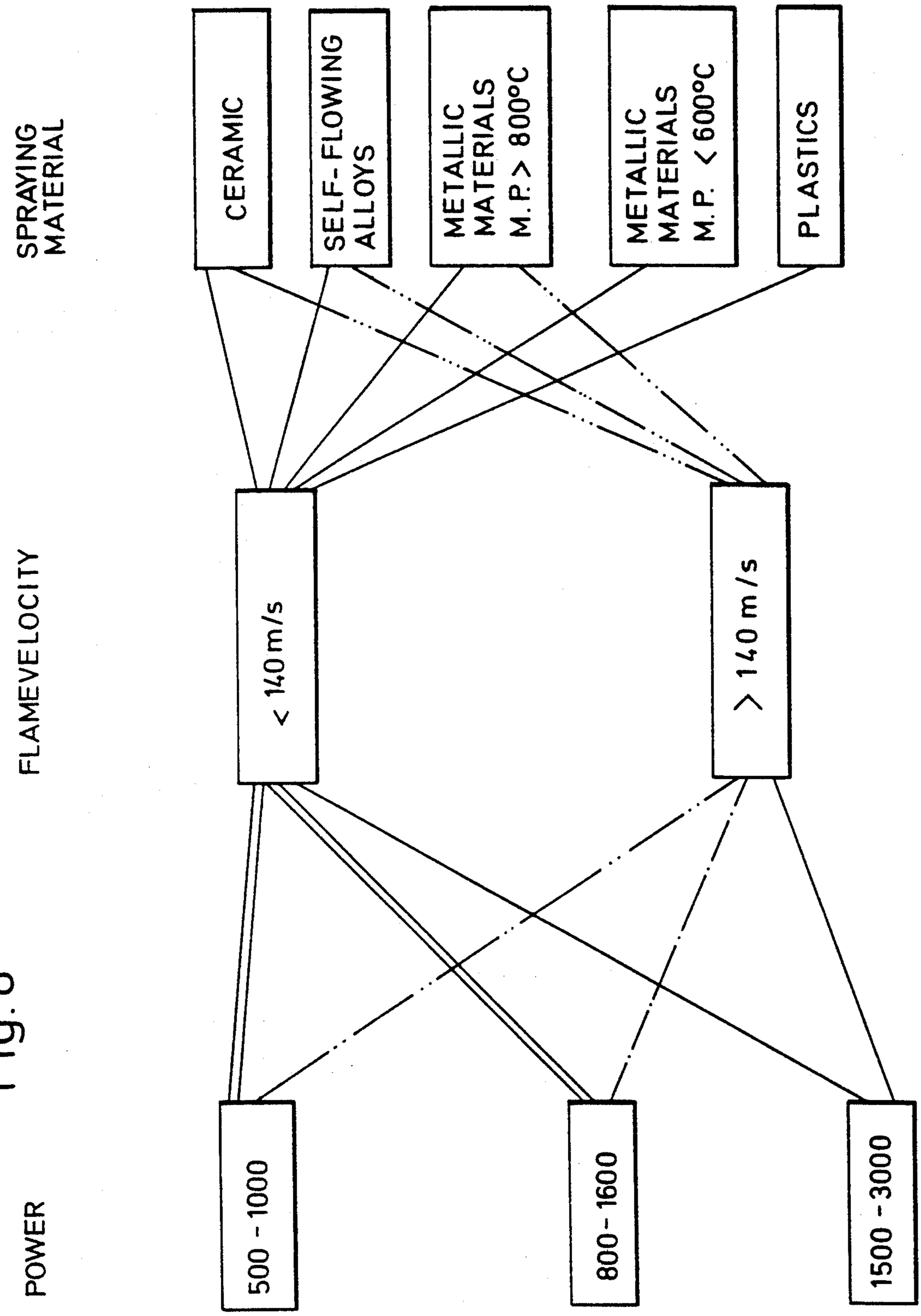
SPRAYING MATERIAL
CERAMIC
SELF-FLOWING ALLOYS
METALLIC MATERIALS M.P.> 800°C
METALLIC MATERIALS M.P. < 600°C
PLASTICS
FLAMEVELOCITY
< 140 m/s
> 140 m/s
POWER
500 - 1000
800 - 1600
1500 - 3000

Fig. 8

AUTOGENOUS FLAME SPRAYING APPARATUS FOR THE FLAME SPRAYING OF POWDER-FORM MATERIALS OR SPRAY POWDER

BACKGROUND OF THE INVENTION

The invention relates to an autogenous flame spraying apparatus for the flame spraying of powder-form materials or spray powder.

Known flame spraying apparatuses of that kind, with injectors for mixing combustion gas and oxidation gas are designed for a given amount of combustion gas mixture, due to the structural configuration thereof, and are fairly complicated in terms of their design configuration. In particular the torch or burner body in the known constructions can only be manufactured with a great deal of difficulty with the desired degree of accuracy in regard to the components which are critical from the point of view of the torch function. Hitherto it has not been possible to increase the degree of structural accuracy and to achieve adaptability of individual components for an extended range of use in respect of the melting point of the various materials in powder form.

In consideration of those aspects the inventor set himself the aim of providing a flame spraying apparatus which is considerably simplified in regard to the structure of its torch body, while permitting inexpensive manufacture with a high degree of accuracy. In addition the invention seeks to provide that the flame spraying apparatus according to the invention covers a wide range of possible uses, that is to say, it can be adapted to a very wide range of spray materials and modes of use.

SUMMARY OF THE INVENTION

That object is attained by an autogenous flame spraying apparatus for the flame spraying of powder-form materials or spray powder by means of a torch or burner nozzle associated with supply lines for the spray powder and for combustion gas, oxidation gas and acceleration gas or mixtures thereof, on a torch body comprising at least two interchangeable main portions, on one of which are provided a nozzle carrier for the releasable torch nozzle and a connection for a powder feed and ducts for the spray powder and carrier gas, wherein the interchangeable nozzle carrier has at least one injector for mixing of the combustion gas and the oxidation gas and ducts for the feed of the gas mixture and a mixture of spray powder/carrier gas to the torch nozzle, whereas provided on/in the other main portion of the torch body are connections for the supply of the combustion gas, oxidation gas and acceleration gas. In addition, regulating valves for the ducts for combustion gas, oxidation gas and acceleration gas are to be associated with said further main portion - that being either outside the actual main portion or however integrated into ducts thereof.

For that purpose, it has been found desirable to provide a separation plane in respect of the torch body, at which 0-rings are provided for gas sealing purposes at the transition between the two main portions of the torch body.

A further separation plane permits fitment of the nozzle carrier to the torch body, while at least one plug element which engages into said body for the non-rotatably fixed nozzle carrier passes through the separation plane.

Moreover the main portions of the torch body are advantageously connected by a holding or clamping means, by means of which interposed sealing elements can be clamped in position.

It has been found advantageous for the described separation planes to be disposed substantially perpendicularly to each other, but in certain constructions they may also be disposed in mutually opposite relationship.

In regard to further features, attention is directed to the claims.

Such a design configuration for the flame spraying apparatus makes it possible for the torch body to be made up on the one hand from a portion which can be produced by machining and in particular by boring of a workpiece of bar material and the degree of accuracy of which is therefore readily sufficient, and on the other hand from a portion which only has the supply and possibly regulating means for the various gases required. In addition it is possible to arrive at a completely modular configuration in respect of the entire flame spraying apparatus and therewith a hitherto unattained range of use with all the advantages resulting therefrom in terms of manufacture, use, operational organization, repair and maintenance and the like.

The connection planes which are provided on the central portion permit the fitment of components which can be easily interchangeable by hand—nozzle carrier, powder feed adaptor or the like—and the opening of an axial powder duct makes it possible to use a carrier gas injector when employing internal conveying and to use the connection for the carrier gas-powder mixture when using external conveying.

The carrier gas injector which can be screwed into position, for sucking the powder out of the powder container which is fitted on to the powder feed adaptor may be provided with a laser-bored synthetic ruby for the injector bore, in order to maintain the degree of accuracy of the amount of powder supplied.

By virtue of the described sides and surfaces of the central portion, it is possible quickly and easily to alter not only the nature of the powder supply but also the power of the flame of the flame spraying apparatus by interchange of the nozzle carrier which includes one or more injectors for the combustion gas/oxidation mixture and the torch nozzle.

The construction of the central portion also provides that, by replacement of the nozzle carrier, the powder supply adaptor and the carrier gas injector or the external powder supply duct, the structure of the flame spraying apparatus can be so adapted that the entire range of use for autogenous flame spraying in terms of flame power, flame velocity and amount of powder can be covered with only one apparatus.

Arranged in the further main portion of the torch body, the feed line housing or valve block, are the connections for the feed of gases such as combustion gas, oxidation gas, carrier gas and acceleration gas, with the regulating valves and the quick-closure valve.

A feed line housing of such a configuration makes it possible—in a manner corresponding to the central portion—to adapt the torch body, by interchange, to the necessary conditions, providing it with one or more regulating valves, with or without quick-closure valve for the gases. The connections or supply lines for the gases may also be adapted as required by means of that procedure.

It will be appreciated that, by virtue of the configuration of the torch body, the combination of the composite apparatus may be modified to such an extent that it

is possible to operate with the entire range of sprayable materials, from plastic material through metals or metal alloys with or without hard substances, metal oxides and refractory metals.

The scope of the invention therefore embraces a large number of embodiments of which in particular those described hereinafter are alternatively of significance:

The central portion or powder conveyor portion:

* has a removable attachment for receiving a powder container and an at least partially interchangeable mixing device for producing the spray powder-carrier mixture, which is connected to the powder container and to a carrier gas duct which in turn is connected to a gas duct of the gas conveyor portion;
* is connected to a feed means of an externally produced spray powder-carrier gas mixture;
* is connected to the nozzle carrier; and
* has gas ducts communicating with conveyor ducts of the supply line housing, for carrying the gases to the nozzle carrier, said gases being supplied to the gas conveyor portion.

The feed line housing or gas conveyor portion is:

** provided at least with conveyor ducts for combustion gas and oxidation gas or
** provided at least with a regulating valve for the combustion gas and with a quick-closure valve for the combustion gas and the oxidation gas, wherein the latter may also be operative for at least a further one of the gases being conveyed;
** connected to a means for the supply of an external carrier gas and has a corresponding conveyor duct;
** is connected to a means for the supply of an acceleration and/or cooling gas and includes a corresponding conveyor duct;
** is provided with at least one second regulating valve for at least a further one of the gases being conveyed, and
** is connected to the nozzle carrier and is provided with a conveyor duct for the spray powder-carrier gas mixture.

BRIEF DESCRIPTION OF THE DRAWINGS

Further advantages, features and details of the invention will be apparent from the following description of preferred embodiments and with reference to the drawing in which:

FIG. **1** is a view in longitudinal section through a flame spraying apparatus;

FIG. **2** is a view on an enlarged scale of a detail from FIG. **1**;

FIGS. **3** through **6** are partly sectional side views of further embodiments of a flame spraying apparatus.

FIGS. **7** and **8** schematically depict the various modular configurations made possible by the apparatus of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1**, a flame spraying apparatus **10** comprises a burner or torch body **12** with feed attachment **14** releasably fitted thereon for a powder container **15** and an also removable nozzle carrier **16**. The latter is fitted to an ,end face **13** of the torch body **12** and is surrounded by a fixing cap tube **17** which is screwed on to the torch body **12** and which with its free end engages over a nozzle ring **18** of a burner or torch nozzle **19**.

The feed attachment **14** and the nozzle carrier **16** are fitted to a parallelepipedic central portion **20** of the torch body **12**; a feed line housing **26** of the torch body **12** is connected to the central portion **20** by screws **24** in the region of an attachment plane **22** which is in opposite relationship to the feed attachment **14**.

A powder duct **28** which extends in FIG. **1** at a right angle to the longitudinal axis A of the central portion **20** in the feed attachment **14** has extending thereacross an aperture means **29** which is for example rotatable,and is aligned with a bore **30** in the central portion **20**, with the interposition of a slider **27** as a shut-off means; the feed attachment **14** can be fitted into position and released only when the shut-off means **27** is closed.

The bore **30** of the central portion **20** connects to a mixing chamber **32** which is formed by a radial bore in a powder conveyor tube **34**. The latter is fitted into an axial bore **36** in the central portion **20** and sealed in position therein with an O-ring 37_a; further **0**-rings in the flame spraying apparatus **10** are also indicated by **37**.

Disposed in opposite relationship to an intake opening **38**, towards the nozzle, in the space **35** in the powder conveyor tube **34**, which space is enlarged at 35_a forming step, is an outlet opening **39** of an injector nozzle **40** which projects from a screw bolt or insert **42** which is fitted into the axial bore **36**.

A transverse bore **44** extends in the screw bolt **42** from a bore (not visible in the drawing) in the shank of the screw bolt **42**, and opens at its other end into a peripheral groove-**45** in the screw bolt **42**. The peripheral groove **45** is disposed in front of a radial bore **46** in the central portion **20**, by way of which oxygen as a carrier gas can be supplied to the injector nozzle **40**.

The feed of the oxidation or carrier gas (oxygen) to the bore **46** is effected by way of an inclined bore **48** and a conveyor duct **51** in the feed line housing **26** which also includes a conveyor duct **52** for combustion gas (acetylene) and a conveyor duct **53** for an acceleration and/or cooling gas (air), and in addition regulating and shut-off members **54** which can be operated for example by way of rotary knobs (not shown), in each of the conveyor ducts **51** through **53**. Reference numeral **56** diagrammatically indicates a quick-closure valve by which the various gases can be rapidly shut off in the desired sequence by means of an operating lever **57**.

Fixed to the feed line housing **26** is a tube portion **25** as a handle, which is disposed around the conveyor ducts **51** through **53**; it is also possible to provide a handle portion of which part is illustrated at **58** and which can additionally be mounted in position, or a fixing device for connecting the flame spraying apparatus **10** to a machine.

The conveyor ducts **52**, **53** are also extended beyond their shut-off members **54** in the form of inclined bores **49**, **50** in the housing **26**, which in turn open into radial blind bores **60**, **61** in the central portion **20**. **0**-rings **37** are used for sealing purposes in the attachment fitment plane **22**.

Gas ducts **62**, **63**, **64**, which are arranged in parallel-axis relationship with each other, extend from the radial or blind bores **46**, **60** and **61** respectively. The gas ducts **62**, **63** and **64** and the radial or blind bores **46**, **60**, **61** are put into the section plane in the drawing for the sake of simplicity, but in practice they preferably extend in different planes.

The gas ducts **62**, **63** go into flow bores **66**, **67** in the nozzle carrier **16**, whereas the outwardly disposed gas duct **64**, opens into an annular space or chamber **68**

between the nozzle carrier **16** and the fixing tube **17**, the space or chamber **68** serving for cooling of the nozzle carrier **16**.

The annular space or chamber **68** is communicated by way of openings **69** with the outside front of the nozzle ring **16**. In operation of the flame spraying apparatus **10**, the openings **69** produce an air sheathing which surrounds the outer part of the torch nozzle **19** and a gas flame which is present thereat.

The nozzle carrier **16** includes a connecting sleeve **70** with nozzle holding means **71** screwed therein. Arranged at a flat connecting surface between the components **70** and **71** is a sealing disc **72** which seals off two annular chambers **74**, **75**. The annular chamber **74** is in communication by way of a flow bore or bores **66** with the oxygen duct **62** and the annular chamber **75** is in communication by way of an inclined bore or bores **67** with the combustion gas duct **63**. Disposed in the nozzle holding means **71** is a further injector nozzle **76** to which oxygen flows from the annular chamber **74** by way of an opening **73** in the sealing disc **72**.

For the combustion gas feed, a radial bore **78** which extends from the annular chamber **75** opens into a mixing chamber **77** at the outlet of the injector nozzle **76**. The drawing does not show that a plurality of, for example three, similar injector nozzles **76** are distributed on the nozzle holding means **71** in the peripheral direction, the gas mixture being supplied from the injector nozzles to the torch nozzle **19** through suitable communicating bores **80**.

The cylindrical torch nozzle **19** is of a two-part construction in FIG. **1**; an inner part **82** and an outer part **83** which is fixedly connected thereto are fitted into suitably central recesses in the nozzle carrier **16**. They also define an annular mixing chamber **84**. Communicating with the mixing chamber **84** are on the one hand the communicating bores **80** and on the other hand a plurality of nozzle outlet ducts **85**.

The inner part **82** of the torch nozzle **19** has a central bore **81** for powder conveying purposes, which is communicated with the interior of the powder conveyor tube **34** which engages into an axial bore **86** in the nozzle carrier **16**, the bore, **86** extending on the longitudinal axis A. The nozzle carrier **16** and the powder conveyor tube **34** together form a plug connection; a fixing pin **87** which is disposed in parallel relationship with the axis is inserted for radially fixing the position of the two components **16**, **20** relative to each other.

In the embodiment shown in FIG. **3** the supply line housing **26** is parallel to the longitudinal axis A of the central portion **20** and the conveyor ducts **51** through **53** terminate at a right angle to the attachment plane **22**. In this constructon, extending on the longitudinal axis A is a powder feed line **43** which is fitted into the axial bore, instead of the above-described screw bolt **42**. Instead of the axially projecting nozzle ring, the torch nozzle **19** is surrounded by an insert ring 18_a which contains the openings **69**.

As shown in FIGS **4** and **4***a*, the supply line housing **26** may also be designed overall perpendicularly to the longitudinal axis A. In this construction the fixing cap tube **17** embraces with its radial collar 17_a an acceleration tube **90** which is clampingly fixed with an annular collar **89** between the tube **17** and the torch nozzle **19** of the nozzle holding means **71**. The acceleration tube is of a double-shell configuration, that is to say, two spaced-apart concentric tubes 91_i, 91_a of different diameters define an annular chamber or space **92** which connects to the upstream-disposed annular space or chamber **68**.

In FIG. **5**, another acceleration tube **95** is carried on the fixing cap tube **17** which is provided with a pressure collar **94** containing the openings **69** which here are disposed inclinedly; the acceleration tube **95** can be axially pushed on to the tube **17**. In front of the torch nozzle **19**, the acceleration tube **95** forms a combustion chamber **96** which decreases in size in a region **97** to provide an axial duct **98**. The tube interior **96** through **98** is surrounded by an annular space or chamber **99** which is integrated into the acceleration tube **95**, as a cooling duct with feed and discharge connections **100**.

The flame spraying apparatus 10_s in FIG. **6** also provides that the powder feed occurs axially at **43**. In this embodiment, a housing attachment **102** is fitted to the rear face **101** of a central portion 20_b with gas ducts **62** through **64** which extend in parallel relationship with the axis. An extension 35_b of the space **35** in the tube passes through the housing attachment **102**. The regulating or shut-off members are integrated in this embodiment in supply lines for the conveyor ducts **51** through **53** outside the flame spraying apparatus 10_s.

In FIG. **1** the spray powder is conveyed from above while in the other illustrated embodiments it is conveyed axially from the rear. In FIGS. **1** through **5** the carrier gas passes from below to the central portion **20** while in FIG. **6** it goes parallel to the powder feed. In constructions which are not shown, spray powder and carrier gas may be introduced parallel to each other from above or below.

Use of the described central block **20**, 20_b admits for example of the following variations:

(a) on a burner or torch with internal powder feed (PF):

1) PF with O_2 of carrier gas internally,
2) PF with O_2 with external carrier gas;
3) PF with external carrier gas,

(b) on a burner or torch with external powder feed (PF):

1) PF with external carrier gas
2) PF with external carrier gas and internal O_2,
3) PF with internal carrier-O_2,

(c) on the burner or torch and the external powder conveyor:

1) refilling with gas return (see paragraph b_3 above),
2) pneumatic powder feed (see paragraphs b_2, b_3 above),
3) electronic control (see paragraphs b_1, b_2 above),

The use of the supply line housing **26** permits for example the variations shown in FIG. **7** of the drawing, while the configuration of the nozzle carrier **16** permits possible uses as shown FIG. **8**.

It will be seen generally from the foregoing that the torch or burner body **12** of the flame spraying apparatus **10**, 10_s forms the basis for a completely modular structure in respect of such an apparatus. Such arrangements preferably use simple plug connections with clamping screw means, which can be released and remade without special tools at the place of work, whereby adaptation to the respective situations of use and interchange for repair purposes is crucially facilitated.

The described division of the torch body **12** in a manner corresponding to the two functions of the powder feed or powder-carrier gas mixture on the one hand and the gas feed or regulation on the other hand can provide for a structural configuration by means of which it is possible to achieve a high degree of accuracy in respect

of the various conveyor ducts in the powder conveyor portion, in a simple and inexpensive fashion.

On the other hand there is also an advantageous line of demarcation in terms of the operating categories of manual operation and automatic operation. The specific construction of the powder conveyor portion and the nozzle carrier/oxidation gas and combustion gas injector assembly further permits an extremely large number of combinations of the elements of the present modular apparatus, which does justice to any specific spray material and any situation of use in an ideal manner.

We claim:

1. An autogenous flame spraying apparatus, comprising:

a supply line housing having a combustion gas supply line, a carrier gas supply line and an acceleration gas supply line;

a main housing connected to said supply line housing and having a spray powder supply line and ducts communicating with said combustion gas supply line, said carrier gas supply line and said acceleration gas supply line, said housing having a first injector, communication with said spray powder supply line and said carrier gas supply line, for mixing said spray powder and a portion of said carrier gas to form a first mixture;

an interchangeable nozzle carrier for carrying a releasable torch nozzle, said nozzle carrier being releasably attached to said main housing and having a second injector, communicating with said combustion gas supply line and said carrier gas supply line, for mixing said combustion gas and a remainder of said carrier gas to form a second mixture, said nozzle carrier also having ducts for conveying said first mixture and said second mixture to said torch nozzle, whereby said nozzle carrier can be replaced so as to alter both flame power and feed of spray powder.

2. An apparatus according to claim **1**, wherein said supply line housing and said main housing are connected at an attachment plane, O-rings being sealingly disposed at said attachment plane at a transition between said combustion gas supply line, said carrier gas supply line and said acceleration gas supply line of said supply line housing and said ducts of said main housing.

3. An apparatus according to claim **2**, wherein said nozzle carrier is attached to said main housing at an end face of said main housing, a plug element engaging between said nozzle carrier and said main housing to provide non-rotatable mounting of said nozzle carrier.

4. An apparatus according to claim **3**, wherein said end face of said main housing and said attachment plane between said main housing and said supply line housing are disposed in mutually opposite relationship.

5. An apparatus accordign to claim **1**, further comprising a clamping means for connecting said main housing and said supply line housing, whereby sealing elements of said main housing and said supply line housing are clamped between said main housing and said supply line housing.

6. An apparatus accordign to claim **1**, further comprising a regulating valve disposed in said supply line housing in said combustion gas supply line.

7. An apparatus according to claim **1**, further comprising regulating valves disposed in said supply line housing in said combustion gas supply line and said acceleration gas supply line.

8. An apparatus accordign to claim **1**, further comprising regulating valves disposed in said supply line housing in each of said combustion gas supply line, said carrier gas supply line and said acceleration gas supply line.

9. An apparatus according to claim **1**, wherein said regulating valves are disposed outside of said main housing.

10. An apparatus accordign to claim **2**, further comprising a feed attachment for said spray powder, disposed in opposite relationship to said attachment plane and being disposed upstream of and communicating with said first injector whereby said spray powder is drawn into said first injector.

11. An apparatus accordign to claim **10**, further comprising a shut-off means for said spray powder, disposed at a connection plane between said feed attachment and said main housing.

12. An apparatus according to claim **11**, further comprising an aperture means, disposed at said feed attachment, so as to regulate feed of said spray powder.

13. An apparatus according to claim **12** further comprising a powder feed tube extending transversely to said spray powder supply line of said main housing and communicating with a mixing chamber of said first injector.

14. An apparatus according to claim **13**, further comprising an inset mounted in and closing a longitudinal bore of said main housing, said longitudinal bore communicating with said nozzle carrier, said first injector being disposed on said insert, said insert conveying said carrier gas from said main housing to said first injector.

15. An apparatus according to claim **14**, wherein said first injector is adapted to be interchangeable for a feed tube for spray powder and said carrier gas from an external powder conveyor.

16. An apparatus accordign to claim **1**, further comprising a powder feed line for feeding spray powder to said main housing, said powder feed line adjoining said main housing in an axial direction.

17. An apparatus accordign to claim **2**, wherein said ducts of said main housing open through radial bores at said attachment plane, and said ducts of said main housing extend substantially parallel in said main housing.

18. An apparatus according to claim **17**, wherein said powder feed line is connected to said main housing through a plug connection.

19. An apparatus according to claim **18**, wherein said spray powder supply line projects out of said main housing and is connected to said torch nozzle.

20. An apparatus accordign to claim **19**, wherein said torch nozzle is a multi-part torch nozzle having an inside nozzle part, said spray powder supply line being connected to said inside nozzle part.

21. An apparatus accordign to claim **20**, wherein said multi-part torch nozzle further includes an outside nozzle part, said inside nozzle part and said outside nozzle part defining a mixing chamber therebetween, said mixing chamber having nozzle discharge ducts extending therefrom.

22. An apparatus accordign to claim **1**, wherein said second injector is disposed in said nozzle carrier upstream of said torch nozzle.

23. An apparatus according to claim **1**, wherein said nozzle carrier comprises a connecting sleeve and a nozzle holding means connected together at an abutment plane therebetween, said second injector being disposed at said abutment plane.

24. An apparatus accordign to claim 1, further comprising a sealing disk having a through opening, said disk being disposed upstream of sad second injector.

25. An apparatus accordign to claim 1, wherein a t least one annular chamber for combustion gas extends parallel to said second injector and communicates with a combustion gas duct of said ducts of said main housing so as to convey said combustion gas to said second injector.

26. An apparatus according to claim 25, wherein said at least one annular chamber is connected to a mixing chamber of said second injector through bores.

27. An apparatus accordign to claim 1, further comprising a fixing cap tube of releasably and gas-tightly bracing one of said nozzle carrier and said torch nozzle to said main housing.

28. An apparatus accordign to claim 27, wherein said fixing cap tube braces said torch nozzle through a nozzle ring disposed therebetween, an annular space being defined between said nozzle ring and said torch nozzle, and an additional annular space being defined between said fixing cap tube and said nozzle carrier, said annular space being connected to said additional annular space, said additional annular space also being connected to an accelerating gas duct of said ducts of said main housing.

29. An apparatus accordign to claim 28, further comprising an acceleration tube fitted on said fixing cap tube and having a combustion chamber which decreases in size in a flow direction of said torch nozzle.

30. An apparatus according to claim 29, wherein said acceleration tube further includes a cooling duct connected to an inlet for a cooling medium.

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